MAY 2016

Military & Aerospace Electronics

ENABLING TECHNOLOGIES FOR NATIONAL DEFENSE

Swarming drones

DARPA moves ahead on developing swarms of cooperating unmanned aircraft. PAGE 4

Rugged cables and connectors

Size, weight, cost, and throughput are focus of today's rugged cables and connectors. PAGE 16

militaryaerospace.com

Networking battlefield combat vehicles

Future combat vehicles need fast networking, cyber security, and situational awareness. PAGE 8

PennWell

Themis Hyper-Unity™

Rugged, Atlantis USX™ Powered, All-Flash Hyper-Converged Infrastructure Platform

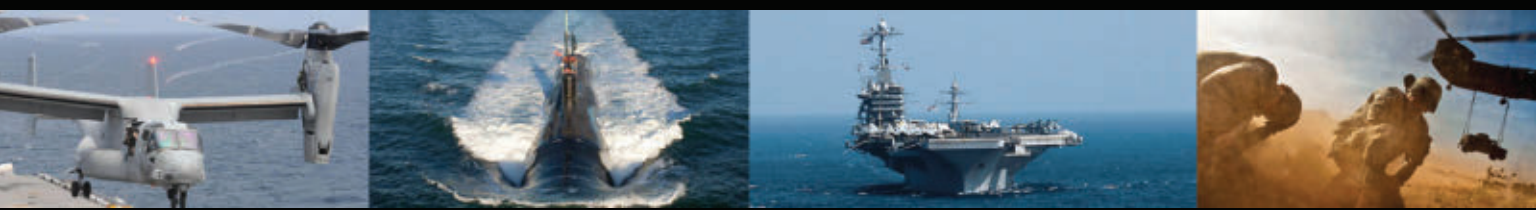
Featuring Atlantis USX, Hyper-Unity is the first turn-key, Mil-Spec, SWAP-optimized, hyper-converged infrastructure platform, to deliver all-flash performance for virtualized applications, at less than half the cost of traditional storage or other hyper-converged platforms.

Atlantis USX-Powered All-Flash Performance
Rugged for Demanding Environments
Robust Resource Management
Rapid, Easy Deployment
Modular Scalability

THEMIS

ATLANTIS

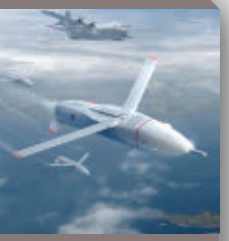
www.themis.com/hyper-unity



47200 Bayside Parkway, Fremont CA 94538 | 510-252-0870 | www.themis.com

MAY 2016
VOL. 27, NO. 5

Military & Aerospace Electronics



COVER STORY

Military & Aerospace Electronics® (ISSN 1046-9079), Volume 27, No. 5. Military & Aerospace Electronics is published 12 times a year, monthly by PennWell® Corporation, 1421 S. Sheridan, Tulsa, OK 74112. Periodicals postage paid at Tulsa, OK 74112 and at additional mailing offices. SUBSCRIPTION PRICES: USA $175 1yr., $309 2 yr., $440 3 yr.; Canada $270 1 yr., $465 2 yr., $600 3 yr.; International $325 1 yr., $620 2 yr., $810 3 yr. POSTMASTER: Send address corrections to Military & Aerospace Electronics, P.O. Box 3425, Northbrook, IL 60065-3425. Military & Aerospace Electronics is a registered trademark.

BY **JOHN KELLER**, EDITOR IN CHIEF

Can U.S. air-to-air missiles stand up to modern enemy electronic warfare?

A recent order for advanced radar-spoofing electronic warfare (EW) equipment got me thinking: How effective are the U.S. military's most advanced radar-guided, air-to-air missiles at defeating enemy efforts to confuse them with electronic jamming? The answer appears to be not so well.

For years, if not decades, U.S. military forces largely have neglected developing not only advanced EW technologies, but also air-to-air missile technologies designed to operate through and defeat the most proficient enemy EW equipment. Today's most advanced U.S. long-range radar-guided, air-to-air missile, the AIM-120 AMRAAM, for example, has been in the inventory for a quarter century, and no longer is considered the world's leading long-range airborne anti-aircraft missile.

The best and most advanced air-to-air missile is a matter of conjecture, with the European Meteor missile, Russian K-37M, and Chinese PL-15 considered the top candidates. The U.S. AMRAAM rarely is mentioned in company with these missiles. U.S. combat aircraft do have a world-leading air-to-air missile, the AIM-9X, but it's an infrared-guided missile intended for dogfighting at relatively short ranges.

Where long-range, radar-guided missiles are concerned, the Meteor, K-37M, and PL-15 beat the AMRAAM in effective range and their ability to defeat the world's best EW technologies, such as the Mercury Systems digital radio frequency memories (DRFM) radar-spoofing jammer.

This dismal picture wasn't always so for U.S. military combat pilots. One of the most capable air-to-air missiles of its day, the vintage Hughes AIM-54 Phoenix, had a range of 100 nautical miles and a speed of Mach 5 — longer range and faster speed than the AMRAAM. Unfortunately the Navy's Grumman F-14 Tomcat carrier-based jet fighter was the only aircraft capable of launching Phoenix; the plane was designed primarily as a Phoenix launcher, although the plane also could launch AMRAAM and the AIM-9 Sidewinder infrared-guided missile.

The F-14 and its Phoenix missiles were operational with the Navy from 1974 to 2006. The last Tomcat was retired from active service on 22 Sept. 2006, and with it went the Phoenix. Nothing else since has had similar air-to-air capability. With the Phoenix missile's retirement and the aging AMRAAM, the Air Force and Navy reportedly put a top priority on developing a next-generation, long-range, air-to-air missile. Even with backing in the Pentagon, however, such a new capability likely would be years away.

Air Force Gen. Herbert "Hawk" Carlisle, chief of the Air Combat Command, calls developing a next-generation air-to-air missile "an exceptionally high priority" for the service. Where the money will come from for such a project remains unclear.

There is a pervasive sense of urgency in the Air Force and Navy to develop a next-generation, long-range, air-to-air missile because the AMRAAM reportedly is no longer a guaranteed first-shot kill when confronting enemy aircraft with advanced EW systems. Instead, some experts say fighter pilots must use as many as three AMRAAMs to bring down an enemy aircraft — even when fired from new military planes like the F-35 Lightning II joint strike fighter and the F-22 Raptor advanced tactical fighter.

It's ironic that the U.S. military plans to spend literally trillions of dollars developing the F-35, and then send this new combat aircraft into battle with the decades-old AMRAAM that can't stand up to its international competition. These developments underscore the dire need for the U.S. military to get itself back up to speed in air-to-air missile and electronic warfare capabilities.

With tight Pentagon budgets into the foreseeable future, will efforts be enough, or is it already too late?

IN BRIEF

COTS parts eyed for Tomahawk shipboard missile control

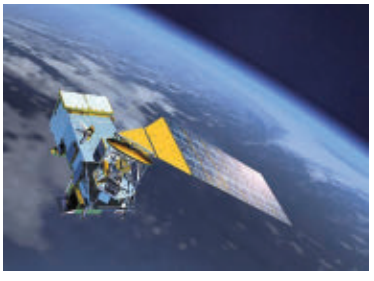
U.S. Navy weapons experts are looking to three electronic parts distribution and logistics companies to provide commercial off-the-shelf (COTS) parts for shipboard missile control systems. Officials of the Naval Surface Warfare Center in Port Hueneme, Calif., are awarding contracts to Crestwood Technology Group in Yonkers, N.Y.; Gideon Services in Huntsville, Ala.; and RC Electronics in Orange, Calif., to deliver certifiable and traceable COTS electronics parts for Tactical Tomahawk Weapons Control System (TTWCS) suites being installed on new ships and retrofitted on existing ships under terms of a maximum $9.9 million, 3-year firm-fixed-price, indefinite-delivery/indefinite-quantity multiple award contract. The Tomahawk Block IV is the latest variant of the Tomahawk cruise missile that has been in the U.S. military's inventory since the 1970s. Navy experts need the contractors to locate and procure necessary parts, provide technical expertise to understand and comply with drawings, identify discontinued or obsolete parts, and reject suspected counterfeit parts.

DDC enhances position in rad-hard space electronics market with Maxwell acquisition

BY JOHN KELLER

BOHEMIA, N.Y. — Executives of avionics specialist Data Device Corp. (DDC) in Bohemia, N.Y., plan to expand their company's offerings in radiation-hardened space electronics with their upcoming acquisition of the Maxwell Technologies microelectronics group in San Diego.

DDC has entered into an agreement to acquire Maxwell Technologies microelectronics, a developer and manufacturer of space-qualified, radiation-hardened microelectronics for satellites and spacecraft.



Data Device Corp. is boosting its profile in radiation-hardened space electronics with its anticipated acquisition of the Maxwell Technologies microelectronics group.

"The acquisition of Maxwell Technologies' microelectronics group greatly expands DDC's solution capabilities for the space industry and other markets requiring radiation-hardened solutions," says Vincent Buffa, president and CEO of DDC. Financial details of the acquisition were not released.

Maxwell microelectronics has provided space-qualified, radiation-tolerant and radiation-shielded products, including semiconductors and single-board computers, to the space industry for more than two decades.

Maxwell's radiation-mitigated power modules, memory modules, and single-board computers incorporate powerful commercial silicon for performance and high reliability in aerospace applications.

Maxwell microelectronics specializes in understanding the radiation performance of commercial semiconductors, qualifying selected components for use in space, integrating them with proprietary radiation mitigation technologies, and manufacturing and screening these products in a DLA-approved, MIL-PRF-38534 facility.

DDC has served the space industry for more than three decades; is approved as a supplier by NASA, ESA, and JAXA; and is certified by DLA to the highest quality level for hybrid microcircuits, Class K, DDC officials say. DDC provides space-qualified, MIL-STD-1553 data bus interfaces, as well as motion control and solid-state power controller products.

FOR MORE INFORMATION visit DDC online at www.ddc-web.com.

DARPA moves forward on plan to develop swarms of cooperating drones

BY JOHN KELLER

WRIGHT-PATTERSON AFB, Ohio — U.S. Air Force researchers are moving forward with a project to use C-130 aircraft to launch swarms of networked and cooperating unmanned aircraft for electronic attack and reconnaissance missions from standoff ranges.

Air Force Research Laboratory (AFRL) officials at Wright-Patterson Air Force Base, Ohio, announced a $3.9 million contract to the Composite Engineering Unmanned Systems Division in Sacramento Calif., for the first phase of the Gremlins program, which relies on relatively inexpensive unmanned aerial vehicles (UAVs) in volley quantities to saturate enemy defenses.

AFRL awarded the contract on behalf of the U.S. Defense Advanced Research Projects Agency (DARPA) in Arlington, Va. Composite Engineering, part of Kratos Defense & Security Solutions, specializes in high-performance aerial target drones, such as the Air Force BQM-167A and U.S. Navy BQM-177A next-generation subsonic aerial target.

The DARPA Gremlins program seeks to launch swarms of small UAVs with C-130 utility aircraft, and use other C-130 utility aircraft to recover as many of these drones as possible. The Gremlins approach would launch swarms of UAVs equipped with surveillance and electronic warfare (EW) pay-

DARPA is beginning to award contracts for its Gremlins project to build cooperating unmanned aircraft able to swarm the enemy with spy and electronic-jamming drones.

CONTINUED ON PAGE 6 ➔

Tektronix®

LICENSE TO THRILL

Each of us are agents of innovation. With our partners in government and military it's a matter of mission – to faithfully serve and protect the people and resources of this country. And we've done so with the full range of advanced electrical test and measurement technologies, from the means to remotely monitor commercial broadcast bands to devices for foreign counter-intelligence. Together we're developing insight systems that enable innovation and assure the integrity of performance in complex systems. And with each technical leap forward we enjoy the satisfaction of creating, the pride in advancement, and the reward of delivering what's needed and what's next.

tek.com/thrill

DARPA CONTINUED FROM PAGE 4

loads beyond enemy air defenses, and then recover surviving UAVs when they have completed their missions.

Composite Engineering's challenge is to design UAVs that are inexpensive enough that occasional losses would not compromise the overall mission. These drones should be able to communicate and cooperate with one another, so surviving drones could assume the roles of those unmanned aircraft lost during the mission.

DARPA researchers want Composite Engineering to develop affordable UAVs that could be reused as many as 20 times for dangerous missions in contested air space like pre-attack reconnaissance and surveillance, as well as electronic attack to destroy or disable enemy communications, missile defenses, and battlefield networks.

These drones would be fitted with diverse payloads in volley quantities, and would have the attributes of small vehicle size, reusability, and limited vehicle design life, DARPA officials say.

Key enabling technologies for the Gremlins program include aerial launch and aerial recovery techniques, equipment, and aircraft integration concepts; low-cost, attritable airframe designs; design for limited life; automated waveoff strategy; precision digital flight control and navigation; aerial refueling techniques; efficient small turbine engines; automated fuel tank inerting and engine shutoff; small distributed payload integration; and precision station keeping.

DARPA is pursuing the Gremlins program in three phases: system and technology design; preliminary design; and prototype flight demonstration. This first phase of the program is expected to involve several different contractors, and spend about $15.8 million.

Ultimately DARPA wants a Gremlins flight demonstration by early 2020 to show the feasibility and potential of air-launched, recoverable unmanned aircraft. Only phase-one contractors will be eligible to participate in the program's second and third phases.

The program seeks to make a fundamental shift in the notion of aerial attack. Instead of using conventional, monolithic systems to conduct missions in denied environments, DARPA wants to use several platforms with coordinated and distributed warfighting functions to saturate adversary defenses.

The idea is to use conventional aircraft hosts to transport and launch a volley of gremlins from stand-off ranges. Researchers want to scale-up the number of UAVs such that a loss of any individual drone is reduced as a result of the collaboration between vehicles.

Not only does the program have the potential to enable enhanced mission effectiveness in contested environments, but it also explores an approach to reduce the cost of operations dramatically.

DARPA officials envision the primary focus of the Gremlins program to be on the technical challenges of aerial launch and recovery of volley quantities of air drones.

FOR MORE INFORMATION visit **Composite Engineering** online at *www.kratosusd.com/about-kusd*, or **DARPA** at *www.darpa.mil*.

Eight companies chosen for $7.2 billion program to fight electronics obsolescence

BY JOHN KELLER

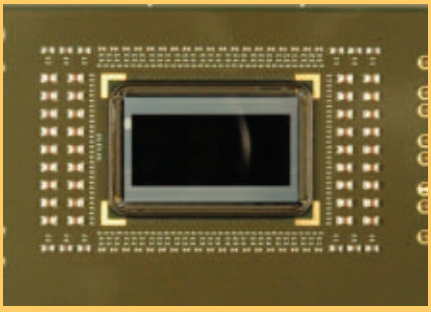
MC CLELLAN, Calif. — Eight major U.S. defense contractors are helping to fight the effects of electronics obsolescence and solve problems of unreliable, unmaintainable, under-performing, or incapable electronics hardware and software under a potential $7.2 billion, 12-year program.

Officials of the Defense Microelectronics Activity (DMEA) in McClellan, Calif., announced contracts to eight companies for the Advanced Technology Support Program IV (ATSP4). The eight ATSP4 contractors are:

- BAE Systems Electronic Systems in Nashua, N.H.;
- The Boeing Co. in Hazelwood, Mo.;
- The Lockheed Martin Corp. Mission Systems and Training (MST) segment in Owego, N.Y.;
- Cobham Semiconductor Solutions in Colorado Springs, Colo. (formerly Aeroflex);
- General Dynamics Mission Systems in Minneapolis;
- Honeywell Aerospace in Albuquerque, N.M.;
- The Northrop Grumman Corp. Mission Systems segment in Linthicum Heights, Md.; and
- the Raytheon Co. Space and Airborne Systems segment in El Segundo, Calif.

These companies will share as much as $7.2 billion in orders over 10 years to support U.S. military technology and weapons development, as well as those of foreign militaries.

Contracts for a second potential $800 million project, part of this program, are reserved for small business and have not been announced.



Some of the nation's largest military electronics houses are helping solve problems of unreliable, unmaintainable, under-performing, or incapable electronics hardware and software.

The ATSP4 seeks to develop a quick reaction capability to develop technologies necessary to keep military systems operational, elevate their sophistication levels, and meet new threats.

ATSP4 orders may include developing components to meet the Pentagon's requirements for ultra-low volumes, extending component availability, or ensuring a trusted, assured, and secure supply of microelectronics.

The job also involves the quick application of advanced technologies to upgrade military weapons performance in response to traditional and irregular threats, as well as to the problems of aging weapon systems.

The ATSP4 program seeks to increase warfighter capabilities and solve electronics support problems like reliability, maintainability, and obsolescence by inserting advanced microelectronics into weapon systems.

The ATSP4 program covers hardware and software and includes studies, analysis, design, software, simulation, prototyping, integration, testing, producibility, and limited production.

Work on the ATSP4 program should be finished by March 2028.

FOR MORE INFORMATION visit the **DMEA** online at *www.dmea.osd.mil*.

Networking vehicles on the future battlefield

The Army Tank Automotive Research, Development, and Engineering Center (TARDEC) uses the Autonomous Mobility Appliqué System to test-drive a variety of new vehicle capabilities.

The U.S. Army and Marine Corps are teaming with industry to develop capabilities for future armored combat vehicles for fast networking-on-the-move, cyber security, situational awareness, and deadly weaponry.

BY **J.R. Wilson**

Ground warfare has undergone evolutionary and revolutionary changes in the past 100 years. First was the arrival of tank warfare in World War I to what has been called the last true tank war at the start of Operation Iraqi Freedom. Then came the networked battlespace since the turn of the century. The first unmanned ground vehicles (UGVs) then came on the scene, and now we see an increased emphasis on networked air and ground sensors to provide unparalleled situational awareness and significant enhancements to vehicle protection and lethality.

Those developments and future evolutions come from the U.S. Army Tank Automotive Research, Development, and Engineering Center (TARDEC) in Warren, Mich. Founded in 1946 as the Tank-Automotive Components Laboratory, TARDEC develops, integrates, and sustains cutting-edge technologies for all manned and unmanned U.S. Department of Defense (DOD) ground vehicle systems and combat service support equipment. It is the nation's laboratory for developing advanced military ground vehicle technologies, process integration expertise, and system-of-systems engineering solutions for force projection, ground vehicle power and mobility, ground vehicle robotics, ground systems survivability, and vehicle electronics and architecture.

TARDEC is focusing today on the Autonomous Mobility Appliqué System (AMAS) architecture for optionally manned vehicles and

developing manned/unmanned teaming technologies and concepts.

"We see AMAS as a standardized way to automate mid- to large-size ground vehicles, something large enough that a human could drive it," says Alex Kade, TARDEC's chief systems architect for ground vehicle robotics. "AMAS enables a soldier to push a button and have the vehicle drive itself — or it can be installed in a fully unmanned platform never designed for a human driver. So it really offers various levels of autonomous mobility by degree, along with networking and improved situational awareness.

"Small ground vehicles are a different architecture on which we've worked using standard robotics," Kade continues. "Right now, we're trying to adopt interoperability profiles developed out of TARDEC. We're working to build a network to ensure all levels of manned and unmanned ground vehicles are coordinated seamlessly and effectively, with a man-on-the-loop, rather than in-the-loop, performing an overwatch function. That is still being developed."

With the end of major combat operations under Operation Iraqi Freedom and Operation Enduring Freedom–Afghanistan, the expectation had been a return to more traditional combat requirements.

Unexpected threats

The rise of many unexpected global threats — the would-be Islamic Caliphate in Syria and Iraq and Operation Inherent Resolve to combat it, renewed Taliban activity in Afghanistan, Russian provocations in Eastern Europe, Chinese sphere-of-influence growth in the East and South China Seas, North Korean nuclear posturing — have renewed demands on U.S. and allied ground and naval forces to respond.

As the U.S. has continued to tighten budgets and significantly draw down its forces across all services, an even greater demand is being placed on enhancing and expanding the capabilities of what remains. That is especially true for the Army and Marine Corps, which have taken some of the hardest hits and face the greatest uncertainties

concerning future adversaries and potential ground combat.

"The goals are to do more for a given unit size — make them more efficient, operations safer, and warfighting more effective," Kade adds. "Convoy safety is one and several other requirements are being drafted, including lightening the load for soldiers at the squad, platoon, and company level, and improving small unit situational awareness using unmanned aerial vehicles {UAVs] and UGVs to look ahead during a mission. A lot of it has to do with how much bandwidth a particular network can support, can we share a clear situational picture and give the local unit a common operating picture."

Industry has responded with a range of technologies, from plug-ins for existing platforms to new vehicles designed for networked, situationally aware operations in extreme environments. For now, the unmanned side is still largely in the prototype and developmental phase for large vehicles, although the use of smaller robotics — which have seen considerable duty in Iraq and Afghanistan — grows and improves with smaller, faster processors enabling more and better sensors in less space.

Much of the technology related to autonomous operations — especially for vehicle situational awareness — is being adapted from the civilian automotive industry, where the move to develop driverless cars is gaining momentum worldwide. While that reduces the cost of research and development for the military, it also makes those technologies available to potential adversaries. There are significant differences, however, that have helped the U.S. maintain a lead in developing and ultimately fielding a new generation of networked, teamed manned and unmanned combat vehicles.

Allied development

Frost & Sullivan Aerospace and Defense Analyst Brad Curran says the only U.S. allies really putting research and operational efforts into ground force networking are France, the United Kingdom, Saudi Arabia, Japan, Australia, and South Korea, all increasing C4 capability on manned vehicles, but not much on UGVs. Israel is a unique case, he adds, where researchers are trying drastically to increase C4ISR capability between advanced unmanned and manned ground and aerial vehicles to speed up the sensor-to-weapons kill chain.

U.S. Army vehicle electronics researchers use the line-haul tractor to explore driver-optional capabilities, from driver-assist features to autonomous leader-follower or waypoint-navigated driving.

"Certainly China is a threat because they produce a lot of the commercial technologies used in a lot of autonomous systems and trying to get American sources for those components is getting more and more difficult," Kade says. "We have to be sensitive to any back doors that might be built into COTS components. Part of the military hardening process is how to make these components more secure, robust, and reliable, which drives the process on COTS components higher.

"We have a lot of initiatives, such as small business innovation research [SBIR] and other collaborative efforts, to increase the capability and manufacturing footprint for a lot of these high-tech components. In some cases, there have been some very interesting developments using SBIRs to get industry to bid on particular projects and programs."

For the Marine Corps, which typically works together with the Army, budget constraints have forced many new and proposed programs to be delayed, canceled, or cut back — including efforts to upgrade legacy platforms and systems. Marine Corps leaders outlined the service's plan for ground forces modernization in testimony on 2 March 2016 before a House Armed Services subcommittee hearing.

Among those testifying were Lt. Gen. Robert Walsh, the Marine Corps deputy commandant for combat development and integration; Brig. Gen. Joseph Shrader, commanding officer of the Marine Corps Systems Command; and William Taylor, program executive officer (PEO) of Marine Corps Land Systems.

"Ground force modernization is focused on high-priority programs such as the Amphibious Combat Vehicle (ACV) 1.1, Amphibious Assault

Vehicle survivability upgrades, Ground/Air Task Oriented Radar (G/ATOR), and Joint Light Tactical Vehicle (JLTV). The ability to coordinate and synchronize distributed Command and Control (C2) sensors and systems is critical to the success ashore," they told lawmakers.

Marine Corps priorities

Marine Corps priorities are G/ATOR, as well as networking on the move. "These systems will provide modern-day, interoperable technologies that support real-time surveillance, detection, targeting, and force protection, in addition to the common C2 suite required to enable the effective employment and situational awareness of the Marine Air-Ground Task Force."

The highest ground modernization priority for Marine Corps combat vehicles is replacing the old Amphibious Assault Vehicle with modern armored personnel carriers. First, the Marines want to field a personnel carrier. Later, they want improved personnel carrier capabilities, a C2 variant, and a recovery variant. The second phase of this project will examine high water speed to extend littoral ship-to-shore maneuver range. When globally sourced, the Amphibious Assault Vehicle program seeks the ability to move the assault echelons of two Marine Expeditionary Brigades.

Oshkosh Defense won a contract to build the Joint Light Tactical Vehicle last year. Marine Corps leaders want to buy 5,500 JLTVs. "JLTV is essentially the first light tactical vehicle capable of functioning as a mobile command post by itself," says John Bryant, Oshkosh Defense senior vice president for defense

The Commando four-wheeled armored vehicle from Textron Marine and Land Systems will help mechanized fighting forces bridge the gap between the JLTV and much heavier Stryker combat vehicles.

programs. "The C4ISR capability normally found in much larger, dedicated mobile command post vehicles are packaged into the much smaller JLTV to provide a very scalable, flexible, and reliable architecture. No light tactical vehicle has ever before been built with that C4ISR, network-ready capability.

"On the JLTV, our integrated C4ISR architecture allows the reception and transmission of video feeds from everything from our driver's vision enhancer — and uncooled FLIR — a more powerful long-range advanced scout surveillance system or from remote weapons stations," Bryant says. "That architecture enables an integrated common operating picture from a number of sensors, with images processed right in the JLTV."

Three requirements drive networking research for tactical wheeled vehicles, Bryant adds: C4ISR capability to support situational awareness, radio systems, IED defeat systems, and video feeds from infrared sensors and weapons stations; the move away from standalone systems to reduce space, weight, and power consumption (SWaP); and increasing cyber security requirements and C4ISR security.

Joint operations

"Effective Joint operations against any land threat will not be possible without ready Army ground combat forces and the supporting units that enable them," said Lt. Gen. Michael E. Williamson, principal military deputy to the Assistant Secretary of the Army for Acquisition, Logistics, and Technology in testimony before Congress in March.

"A properly sized, equipped, and ready Army makes it possible for the Joint Force to deploy in sufficient scale and duration to prevent conflict, shape security environments, and provide multiple options for resolving crises and winning decisively," Williamson told Congress.

Army leaders are emphasizing a robust network protected from cyber attacks. Key investments will include the Warfighter Information Network-Tactical (WIN-T) "networking-on-the-move" capability throughout division, brigade, battalion and company levels. Employing military and commercial satellite connectivity and high-capacity, line-of-sight connectivity, WIN-T Increment 2 is in full rate production and fielding.

Another high priority is assured position, navigation, and timing in the absence of the GPS system for infantry and mechanized forces. Of interest are non-GPS augmentation, pseudolite transceivers (an alternative source of GPS-like signals) and anti-jam capabilities in a hub system that distributes an assured position, navigation, and timing to vehicles and foot soldiers.

Also of interest are communications security (COMSEC); offensive and defensive cyber warfare; cyber situational awareness; a new ground mobility vehicle; Stryker vehicle upgrades; mobile protected firepower; and a new armored multi-purpose vehicle.

The Ground Mobility Vehicle will fill a mobility gap in the infantry brigade combat teams. Stryker lethality upgrades will help increase mobility, electrical power, and network upgrades, including building double V-hull upgrades to increase vehicle protection from land mines and improvised explosive devices (IEDs)

Mobile protected firepower involves large-caliber, vehicle-mount guns to defeat enemy prepared positions, destroy enemy armored vehicles, and fight enemy combat vehicles. The Armored Multi-Purpose Vehicle, meanwhile, will replace legacy M113 armored personnel carriers at the brigade level and below.

The Armored Multi-Purpose

Vehicle will fill five roles: general-purpose vehicle, mortar carrier, mission command, medical evacuation, and medical treatment.

Enabling technologies

Among the chief enabling technologies for manned and unmanned combat vehicles are small-form-factor switches able to withstand punishment in the field while increasing vehicle data throughput in a small size and weight, says Ronen Isaac, general manager of rugged Ethernet specialist MilSource in El Segundo, Calif.

"We have another program for a much larger unmanned vehicle, an off-shoot of Lockheed's Squad Mission Support System," Isaac says. "They are putting two switches on board to connect radios and computers and have spread the load out, connecting multiple sensors inside of the vehicle with separate switches to connect to the radio."

Army research investments focus on enabling warfighters to operate not only in contested environments, but also to win decisively against any potential adversary. Efforts include the Modular Active Protection System program to increase vehicle survivability and protection; electronic warfare (EW) efforts against enemy helicopters, vehicles, and foot soldiers; combat vehicle prototyping; degraded-visibility systems; and sensor protection.

Two programs Williamson and Murray termed critical to providing soldiers with the best intelligence tools and technology are an updated version of the Distributed Common Ground System-Army (DCGS-A) and JLTV, which provides a leap in protection, performance, and payload.

"The Army has started to work on manned and unmanned teaming with UAVs and we expect them to do the same with UGVs. Increased situational awareness and ISR for manned ground vehicles is definitely a trend for the future, such as updating Stryker and Bradley, based on the VICTORY architecture," says Frost & Sullivan's Curran. VICTORY stands for Vehicle Integration for C4ISR/EW Interoperability.

"They need more computing power, more raw power, and the ability to distribute it, because all these platforms will have better

electro-optical sensors, active protection measures, counter rocket and mortar systems, improved situational awareness, and communications ability," Curran says.

VICTORY-based standardization of connector and power assets help vehicle electronics designers integrate advanced sensors as they come online through the 2020s.

Sensors and communications

A key effort now is to take the new sensor and communications technologies that have been added to existing platforms during the past 10 years and develop integrated systems that are more sustainable and interoperable across platforms. One of the key enabling technologies involves the industry's vast increases in computing power.

"FPGAs [field-programmable gate arrays] and small-form-factor, powerful computers such as those from Mercury, leveraging commercial products such as Dell's Toughbooks and wireless technologies developed for commercial smartphones — all those mature technologies that can be reliably applied to a tactical environment," Curran says. "Compute-intensive systems, such as radars, software-defined radios, and other power-hungry systems can use the application of commercial technology."

Textron Marine and Land Systems in Slidell, La., is working on networking and situational awareness in the company's family of Commando four-wheeled armored vehicles and its driver vision enhancement and vehicle information systems. The Commando vehicle integrates a lot of growth and capability in onboard image processing, which is essential to situational awareness.

"There have been several advances

Scientists at the John Hopkins Applied Physics Laboratory in Baltimore are working on the Advanced Explosive Ordnance Disposal Robotic System, shown above.

The Textron Commando combat vehicle is a test bed for vehicle networking, situational awareness, driver vision enhancement, and vehicle information systems.

in video processing and graphic image processing, as well as electro-optical sensors to improve the video image," says George Ramirez, Textron senior engineering consultant. "With the advent of HD video and fusion of video images, you have an enabler for situational awareness. The resolution of the video image helps identify specific targets with long-range sensor optics for reconnaissance and surveillance missions.

"At a strategic level, in an insurgent environment, it allows you to get more detailed about what is going on around you than before and improves speed of response," Ramirez continues. "In a more conventional situation, there would be a lot of data moving about the battlespace and the whole operation would accelerate quite a bit."

As how manned and unmanned ground vehicles will deal with future threats, Larry Jepson, Textron's director of engineering for land systems, sees a muddled picture.

"The whole Iraq/Afghan insurgent effort has been a very, very strong force on how the U.S. Army does things and the equipment it needs, Jepson says. "That is a fundamentally different environment than what we were looking at in the 1980s and '90s.

The Marine Corps, Army, and Pentagon researchers continue to experiment with UGVs to extend battlefield situational awareness, but the fielding of unmanned ground platforms continues to lag behind UAVs and naval unmanned surface and underwater vehicles, Jepson says. End-user skepticism about UGVs also reflects similar initial doubts about UAVs and UUVs.

"Money is tight, forces are shrinking, and maintenance is being deferred," Frost & Sullivan's Curran says. "Incremental improvements to utilize new technologies, based on standards-based computers and connections, will be the wave of the future. There will be fewer but more capable platforms, based on less-expensive, non-proprietary, standardized equipment and architectures."

Connectors and cables prove critical to modern system designs and upgrades

Military and aerospace engineers focus on cable and interconnect size, weight, cost, and throughput for new and retrofit electronics projects.

BY **Courtney E. Howard**

Military and aerospace engineers, recognizing the criticality of cables and connectors, are weighing cabling and interconnection design considerations and product options early on and throughout workflows today. They also are increasingly meticulous about selecting the optimal cable and connectors, mulling over a lengthy list of application-specific questions and considerations.

Real-world requirements

Connectors and cables in military and aerospace applications strain under a load of requirements, as do the engineers responsible for choosing the correct component for the job. Like the aerospace and defense vehicles and systems that rely on them, cables and interconnects must withstand long life cycles, often spanning many decades; operate in harsh conditions that involve vibration, exposure to saltwater, and temperature extremes; and, in some cases, withstand the wear and tear of repeated plugging and unplugging.

In military and aerospace applications, ruggedization is one of the most important differentiators from interconnects and cables designed for commercial applications, says Tony Padula, product manager at Amphenol Pcd in Beverly, Mass. Military and aerospace interconnects "need to withstand extreme temperatures, vibration conditions, and a variety of different environmental fluids." If designers use interconnects in a wheel well, for example, they come in contact with potentially damaging fluids and chemicals like antifreeze.

Generally speaking, modern military aircraft and unmanned systems have a much more diverse mission than their predecessors, says Mike Savage, director of product management for aerospace and defense at ITT Interconnect Solutions in Irvine, Calif. "They are exposed to a wider variety of environmental conditions, including significant shock, vibration, and extreme temperatures, where they are expected to operate for extended periods."

Also important is the growing need to shield sensitive electrical connections from electromagnetic interference (EMI) and pulse (EMP), as well as electrostatic discharge (ESD), Savage adds. "We're seeing more of this as the spectrum becomes more congested and contested, and electronic and information warfare become more prevalent."

"Military platforms are flying today with more sophisticated onboard sensors than ever before. They often need to transmit high-resolution, multispectral imagery and other kinds of data around the clock," says Savage. "Today's imaging data requirements are in the gigabit range, which means connectors must

TE Connectivity's rugged connectors help bring fiber-optic technologies to harsh environments.

continually improve to keep ahead of these mission requirements." This trend is driving the demand for higher data rates, and steering product development efforts, resulting in new high-bandwidth, radio-frequency (RF) and data connectors capable of functioning in the multi-gigahertz and multi-gigabit ranges, he adds.

Interconnect considerations

"When selecting mil/aero connectors, one must consider the environment where the cable assembly will be used," says Mike Dabrowski, market director of military/aerospace at Amphenol Fiber Systems International in Allen, Texas. "What are the environmental conditions? Will there be temperature extremes? Does the connector need to be environmentally sealed? Is the environment particularly sandy or corrosive (e.g., seawater)? What are the on-the-ground requirements? Does the

connector need to be shock-proof or withstand high-vibration events? Does the connector need to be mated and unmated frequently?"

Performance also is a big consideration. "Is it carrying power and signal? Are there requirements for higher bandwidth? Are there thermal and environmental challenges? The overarching requirements are: what does it have to do and in what environment," asks Earle Olson, business development manager at TE Connectivity in Harrisburg, Pa. "Does it roll, float, or fly, and then whittle it down to discrete aspects, such as the moisture content, like heavy salt fog in naval applications."

When it comes to selecting cable, "a lot of it has to do with the application," says Robert Moore, product development engineer at TE Connectivity. "Temperature rating is key to selection, especially hook-up wire. Wire is sized to the current it is carrying. If the temperature rises, that current will impose on wires carrying power," and from an environmental and safety perspective, can result in smoke, toxicity, and flammability. When we get into data cables — coax or something transmitting high-speed data like Ethernet — it is important to select cable that meets temperature, environmental, fluid resistance, and electrical requirements." In the end, it all has to hook up to connectors and still provide data integrity.

Signal integrity

Integrity is of paramount importance in cable and connector selection, military and aerospace experts agree. "The job of a connector, essentially, is like that of a sensor: to take the signal that comes in and pass it though as purely and cleanly as possible," explains W. Dale Albert, sales director at Amphenol Pcd.

"As speeds go up and voltages decrease, signal integrity design and management is critical to the functions needed in military and aerospace," says Bob Stanton, director of technology at Omnetics Connector Corp. in Minneapolis.

ITT Cannon provides OctoGig 10 Gb Ethernet solutions for aviation and marine applications.

Matching the design to the electrical application of the circuit is the key consideration for connector to cable design, he says. "Digital signal quality is more often assured by using differential cable design that matches the impedance of the output and or input system of the processor boards and detectors.

"Proper shield and drain wire interconnections increase the accuracy of the system, and help insure appropriate eye pattern quality of the transmitted signal through the connector and cable assembly and reduce jitter and crosstalk," Stanton adds. "Reduced size, lower weight, and ruggedness immediately follow in the list of important specifications to serve the needs of portable ground troop electronics; airborne equipment, such as unmanned aerial vehicles (UAVs); and satellite systems." Further, military connector designers must seriously plan and implement the use of military pin to socket elements that exceed the minimum requirements of wear during insertion and retraction force.

"Non-military connectors differ predominately in one or more of these considerations," Stanton says. "Most often, I see differences in commercial connectors when designers use connector brands that do not manage pin to socket systems and have low inter-mate strength and poor plating on the pin and socket elements that wear out early."

Cable-run length also is a big consideration. "System-to-system engineers should review carefully the distance from one box to the other and help manage the potential attenuation of smaller, high-speed circuitry in the cable," says Omnetics's Stanton, who also advises planning for electromagnetic interference (EMI) protection that ensures clean lines without noise or even cyber intrusion. "Close proximity can breed crosstalk and skew that will affect signal quality. Mechanical mounting on boards should be tight and clean. New latching micro and nano connectors can help with mating and non-mating."

Military-grade versus commercial

Experts might differ as to which cable and connector characteristics are most important, but many agree that determining whether

commercial off-the-shelf components are appropriate for the project is a good first step.

"Comparing mil/aero to commercial connectors and cabling is like comparing tires on a golf cart to tires on a Formula 1 racer. They are a completely different animal," says Pasternack's Rachlin. "The temperatures, pressures, environmental conditions, and mechanical strain are just a few of the areas where mil/aero cables and connectors have much wider and more stringent specifications."

Military vs. commercial has additional considerations. "Where commercial and military needs can differ is that for commercial customers, the goal is to help deliver a more comfortable and enjoyable passenger experience, while the emphasis for military customers often centers on standards and specifications for hardened systems, ruggedness, and performance under more demanding conditions than those typically experienced by commercial aircraft," says ITT Interconnect's Savage.

Interconnects used in aerospace and defense must comply with different specifications than those used to govern commercial interconnects. "The requirements are not always tougher, but they take a different approach," explains Thomas Heller, regional account manager, aerospace and defense, at Molex Inc. in Walldorf, Germany. "Besides customer-specific specifications, there are general aerospace and MIL requirements provided by different authorities," including EN (European), VG (German defense), and Radio Technical Commission for Aeronautics (RTCA) standards.

These specifications reflect different environmental conditions and chemical immersion conditions, as well as different fire, smoke, and toxicity (FST) requirements. On top of this, there are different installation requirements. Since most harnessing and termination operations will be performed inside the aircraft cabin, most interconnect items must be field terminable."

Product engineering teams at ITT Interconnect, for example, are always "working to make connectors standard-ready," Savage says. The company's aluminum and composite

Redundant release

Eaton's redundant-lanyard-release connector meets NASA requirements.

SpaceX engineers in Hawthorne, Calif., have qualified a redundant-lanyard-release connector from Eaton Aerospace Group, part of Eaton Corp., in Irvine, Calif., to facilitate the separation of the SpaceX Dragon capsule and trunk shortly before re-entry into the Earth's atmosphere. "This connector was designed to meet NASA's redundant-release requirements and has also been qualified to facilitate the release of propulsion stages, fairings, crew modules, and parachute covers," says Dennis Brondi, marketing communications manager at Eaton Aerospace Group in Irvine, Calif. Eaton's redundant-release plug incorporates Series III compliant threads and can be used in weapons-system applications, to help facilitate the release of airborne ordinance.

Circular Series III connectors are certified to EN3645 in Europe and MIL-DTL-38999 in the U.S., for example. EN3645 certification, which enables the connectors to be used by European original equipment manufacturers (OEMs) and supply chain companies that abide by the EN3645 standard, follows rigorous testing, site audits, and data collection by AeroSpace and Defence Industries Association of Europe — Standardization (ASD-STAN).

Customers increasingly are standardizing around Qualified Products Lists (QPLs), says Amphenol's Albert. Engineers also work closely with industry leaders, including Boeing and Airbus, which have their own standards. Many interconnects are made to an EN, QPL, or European Digital Economy and Society Index (DESI) standard, he says.

"Some customers are lax on standards so they can use commercial off-the-shelf or something lower cost, but there are trade-offs," Albert says. "The engineer has a tough job, figuring out: 'What are the trade-offs in terms of performance and quality if I don't use mil-spec and use a standard off-the-shelf product? Some trade-offs could be: the contact system is less expensive, but not qualified to mil-spec, or plating on the connectors is not Restriction of Hazardous Substances (RoHS)-compliant."

Sometimes a trade-off is unnecessary, so engineers and engineering managers are encouraged to investigate all the available options. "Mil-spec standards have minimum requirements for gold plating — you want it on active areas. To reduce overall costs, choose selectively plated contacts," recommends Amphenol's Padula.

"If you don't see what you are looking for online or in a catalog, do not assume it hasn't already been

developed; it may be available," Savage says. "We have done many application-specific designs for customers that can be leveraged for new applications, and it does not necessarily mean significant tooling investments or long lead times. Many technologies exist already and just need to be applied to different connector platforms."

Standards-based selection

Military and aerospace customers typically demand standards-based products, which deliver robustness, reliability, and consistency. "There is an increasingly strong preference toward standards-based solutions and away from vendor proprietary products," Amphenol's Dabrowski says.

The Defense Logistics Agency (DLA), the U.S. Department of Defense's logistics combat support agency at Fort Belvoir, Va., has migrated to SAE Aerospace Standards (AS) from SAE International, which owns ARINC standards, in Warrendale, Pa. "The DLA has a good number of military specifications (mil-specs), and many mass market ones moved to AS," says TE Connectivity's Olson.

"For custom cable assemblies, requirements that we are seeing include NAVSEA S9320-AM-PRO-020/MLDG-certified overmolding," says Dennis Brondi, marketing communications manager at Eaton Aerospace Group in Irvine, Calif. A torpedo-control cable assembly includes a custom connector and a clear NAVSEA-PRO-20-compliant overmold, for example, that provides visual confirmation that all wires are correctly terminated and the overmold is void free."

Some industry standards that began as military specifications have evolved into SAE standards. "From a wire and cable perspective, large OEMs have written specifications for use that were originally mil-spec and are now AS spec," says TE Connectivity's Moore. "SAE over the past year has come out with a standard for high-speed data cables (AS6070)."

Customers also value various cable assembly certifications and compliances — including IPC J-STD-001E, IPC 620, NASA-STD-8739.4, MIS-20887, and MPD-7011 — and are concerned with International Traffic in Arms

Regulations (ITAR) technology control plan requirements for weapons-systems applications, Brondi says. For connectors, he and his colleagues see "the usual specification requirements associated with command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) and weapons-systems applications; e.g., MIL-DTL-38999, MIL-DTL-55116, MIL-STD-1553, etc."

Most customers now require an AS9100-quality system, Amphenol's Drabowski says. In addition to the AS9100 aerospace industry standard, Dabrowski sees standards like Telcordia GR-326, IEC 61300-3-35, and IPC 8497-1 being invoked more frequently on customer specifications. "Customers want to see supporting test data to demonstrate that a product being offered lives up to what the datasheet says it should live up to."

Designers should consider comparing operating environments when looking at standards. "When selecting connectors that are not defined by military specifications, consider including compliance to military specifications for similar-environment solutions as a selection requirement," Eaton's Brondi advises. "For example, since the form factor of the Eaton micro-military connector is a de facto industry standard with no formal military specifications, engineers should consider including supplier-provided qualification reports documenting compliance to MIL-DTL-38999 specifications (including but not limited to: insulation resistance, dielectric withstand voltage, temperature cycling, durability, shock, and vibration) as part of their selection criteria. Supplier-provided qualification reports should also document intermateability with similar connectors from other manufacturers to ensure that the receptacle selected by an electronics OEM will mate with the plug selected by a cable manufacturer."

Eaton's umbilical connector facilitates first-stage separation in launch-vehicle applications.

Test results

A rather long list of mil-specs and application-specific requirements for mil/aero components exist and pertain to the suppliers, facilities, and quality of manufacture of the component, says Pasternack's Rachlin. "ISO 9001 and IQnet certification really provide confidence that the organization you are ordering from is efficient, effective, and has enough credibility to provide the quality of parts and business necessary for mil/aero applications. For mission-critical systems, it is important to know your supplier is experienced and knowledgeable enough to get the orders right, and have the proper testing capability to prove it."

"There also are qualification tests, such as MIL-T-81490 and MIL-DTL-87104, which specify the general requirements for transmission lines and coaxial assemblies," Rachlin says. "Additionally, MIL-STD-202 dictates the requirements for testing electronic and electrical component parts."

In addition to mechanical and environmental requirements, military standards exist for electrical specifications such as radio-frequency (RF) leakage, and power usage on the cable. These requirements are just the tip of the iceberg, Rachlin says. "Most mil/aero applications have their own set of stringent requirements that may exceed the standards. Custom specifications could be mechanical, environmental, or electrical in nature." For these reasons, having sophisticated and certified testing in-house is important for many buyers of cable assemblies.

Size, weight, and speed

When it comes cables and connectors for military and commercial aircraft, "it's all about smaller, lighter, and faster," Savage says. "It's also about cutting fuel costs, reducing the overall weight of the aircraft, increasing safety, and moving to faster and better data networking and data transfer rates." To reduce fuel costs, you must reduce the weight of the aircraft; one of the ways ITT Interconnect has addressed this is to move from aluminum to composite connectors, where appropriate, he says.

Savage is seeing growing demand for high-bandwidth applications that deliver data to pilots and passengers from an increasing variety of onboard sensors and systems, as well as off-board ones, such as satellite or ground-based Internet connectivity.

"To achieve faster data transfer speeds, it's important to understand how data collection and dissemination is changing on modern commercial platforms," Savage says. "High-speed sensing occurs throughout the aircraft, producing data that is sent to the pilot, who views it on a flat, graphical user interface (GUI) or a head-up display (HUD). More data than ever before has to be processed and transmitted visually to the pilot.

Pasternack offers rugged, stainless-steel SMA and N Type armored test cables and connectors.

As a result, bandwidth needs in the cockpit have increased significantly."

Mobile, miniature, and modern

Providers of interconnect technologies are seeing greater demand for ruggedized, miniature connectors to interface with more complicated cable systems designed to handle very fast and clean digital signals.

"From high-speed Ethernet to surveillance cameras and onto portable computers serving helmets, there is a move to highly mobile military systems," Omnetics's Stanton observes. "Hand-launched drones and robotic ground monitoring systems all fit into the new push within military upgrades.

"Older aircraft are being modernized with higher-speed, digital electronic modules replacing older analog systems. The connector and cable systems are designed differently to serve that new era," Stanton adds. "Standard micro and nano connectors are often easily modified to meet that demand and adjusted to fit into smaller, tighter spaces within electronic packages."

As power and high-speed signals combine in reduced size, weight, and power (SWaP) formats, Stanton is seeing newer micro circular cable and connectors using hybrid designs that include 3 to 5 amp pins included in the same housing as multiple sets of high-speed digital interconnections. These hybrids span the design range from miniature rectangular to miniature and nano-miniature circular connectors, he says. For example, rugged, micro circular connectors with very small, flexible wiring are used to route both power and digital signal processing data at speeds up to 3 Gigabits per second from ground soldiers' computers to helmet displays, Stanton says.

Omnetics Connector Corp.'s family of Micro and Nano connectors are designed to deliver power and digital signals for military and aerospace applications.

COMPANY INFO

Airborn Inc.
www.airborn.com

Amphenol Pcd
www.amphenolpcd.com

Amphenol Fiber Systems International
www.amphenol-fsi.com

Eaton Interconnect (formerly Cooper Industries)
www.cooperindustries.com

Digi-Key Electronics
www.digikey.com

Glenair Inc.
www.glenair.com

Harwin
www.harwin.com

HiRel Connectors
www.hirelco.net

ITT Interconnect
www.ittcannon.com

J.A.S. Interconnect
www.jasinterconnect.com

LEMO Connectors
www.lemo.com

Minnesota Wire
www.mnwire.com

Molex Electronic Solutions
www.molex.com

Mouser Electronics
www.mouser.com

Multi-Contact
www.multi-contact.com

Newark Electronics
www.newark.com

Omnetics Connector Corp.
www.omnetics.com

Pasternack
www.pasternack.com

TE Connectivity
www.te.com

Commonality and crossover

Modern aerospace and defense applications are focused on open systems, rather than proprietary solutions. The Vehicular Integration for C4ISR/EW Interoperability (VICTORY) initiative for vetronics, The Open Group technical standard for the Future Airborne Capability Environment (FACE) for avionics, and Hardware Open Systems Technologies (HOST) for shipboard electronics are prime examples of the continuing trend toward open, modular architecture in military and aerospace.

"What was done 20 years ago doesn't work that well today. Gone are the days of purpose-built. A lot of solutions are moving to something more easily applied and easier to handle," to move current technologies to the warfighter faster, explains TE Connectivity's.

Requests for commonality are increasing, says Amphenol's Padula, and there's a focus on boxes and connectors as a fully integrated system. Further, high-speed signals requirements — such as for USB 3.0 and 3.1, and HDMI — are being driven by the telecommunications community and making their way to avionics systems designs. Engineers are driving the industry toward interconnects that are faster, smaller, more lightweight, and higher bandwidth, he explains.

Ongoing upgrades

A lot of radars, especially airborne and shipboard radar, are being upgraded, acknowledges TE Connectivity's Olson. He is seeing "a lot of activity that requires a better solution set," and aerospace and defense organizations performing upgrades "so that systems on board are more capable." Cables and connectors are an integral part of these modernization efforts.

Military vs. commercial considerations

According to Dennis Brondi of Eaton Corp., in addition to environmental and mil-spec compliances, design considerations and differences between military and commercial products include:

- mission criticality, whereby two plates containing mating connector arrays must demate to facilitate separation of the expended first rocket stage from the spacecraft;
- solution complexity in which each connector array comprises 12 connectors and mission defined mixed-mode contact configurations to support signal, data, and power connectivity;
- separation system with force-balanced spring towers and redundant release mechanisms;
- refurbishable and upgradeable designs;
- facilitates reusability and "forward compatibility" as MIL-DTL-38999 derived shells and inserts can be readily changed to support changing mission requirements; and
- program life cycles as long as 30 years.

Consolidated Afloat Networks and Enterprise Services (CANES), the U.S. Navy's next-generation tactical afloat network, represents a new business model for delivering capability to the fleet. Many CANES upgrades are implementing fiber-optic data management, including fiber-optic cables and connectors, on DDG-class destroyers. "Everything is being upgraded," Olson says, to deliver more information and a better experience to the end user behind the radar screen.

The end game is to provide military personnel with everything they have come to expect from handheld electronics, like their personal smartphones, Olson explains. Systems "combining data and imaging and full motion video and communications" and "dealing with satellite communications, perishable data, and video all at once. You're not going to do that with standard old MIL-DTL-38999 Series III connectors with 128 contacts; it's just not going to work. That's why you see RF and fiber and power — but not necessarily in one connector, because that's one massive single point of failure."

"Take a system approach," Olson recommends. "Consider the signal path from beginning to end. Be holistic in your thinking. Over the past 35 years, that's one thing that keeps being relearned. Whole platforms will be designed by a cable engineer, connector engineer, and performance engineer and they won't talk to each other. Instead, break it down for everyone involved." It is happening more and more in engineering workflows, he says, and hopefully it is going to continue.

Similarly, engineers are encouraged to communicate and "work with suppliers early and often," Albert explains. "The earlier they can get us involved, the better. It doesn't take one meeting; it takes several iterations. Have an open dialog on what you're trying to accomplish, beyond the cable or interconnect, so we can bring the right solution. If we understand the big picture and where you really want to go step-function-wise, we can position product to save a lot of time and redesign down the road."

General Dynamics to provide maritime radios

U.S. Navy shipboard communications experts are placing a $12.9 million order with General Dynamics to provide AN/USC-61(C) maritime radios for Navy surface warships and submarines. The Space and Naval Warfare Systems Command (SPAWAR) in San Diego is asking the General Dynamics Mission Systems segment in Scottsdale, Ariz., for the continued production of the AN/USC-61(C) Digital Modular Radio (DMR), initial sparing components, and related supplies and services. The General Dynamics AN/USC-61(C) shipboard radio enables surface ships and submarines to communicate over high frequency (HF), ultra-high frequency (UHF) line of sight, UHF satellite communications (SATCOM), and very high frequency (VHF) radio bands. The compact, multi-channel AN/USC-61(C) operates on Navy surface ships, submarines, and other military platforms using frequencies from 2 MHz to 2 GHz. General Dynamics certified the maritime software-defined radio (SDR) to pass secure voice and data at multiple independent levels of security (MILS) over HF, VHF, UHF, and SATCOM channels and withstand the effects of electromagnetic interference and other harsh operating conditions.

Raytheon wins billion-dollar contract for airborne electronic warfare

BY **John Keller**

PATUXENT RIVER NAS, Md. — U.S. Navy airborne warfare experts are moving forward with a plan to upgrade the EA-18G Growler electronic warfare (EW) aircraft with new state-of-the-art electronic jammers to suppress and inject computer viruses into enemy digital radar and communications systems.

Officials of the Naval Air Systems Command at Patuxent River Naval Air Station, Md., announced a $1 billion contract to Raytheon Co. to build and test 15 Next Generation Jammer (NGJ) aircraft-mounted pods in support of NGJ full-scale development. The NGJ is a tactical electronic jammer pod that replaces the 40-plus-year ALQ-99 jammer system on the EA-18G, a version of the Navy's carrier-based two-seat F/A-18F Super Hornet jet fighter-bomber that is modified specially for electronic warfare.

The EA-18G leads an airborne attack by disrupting enemy radar, communications, and computer networks with jamming signals and computer viruses. The aircraft also can destroy enemy radar installations with its AGM-88 High-speed Anti-Radiation Missiles (HARM).

The contract to the Raytheon Space and Airborne Systems segment in El Segundo, Calif., calls for 14 NGJ aero-mechanical test pods to verify aircraft flying qualities and pod safe separation from the host aircraft; equipment for system integration laboratories; and mature manufacturing processes.

Raytheon is developing advanced prototypes of the future Next Generation Jammer (NGJ) for the Navy EA-18G Growler electronic warfare aircraft, shown above.

Raytheon's NGJ will integrate advanced electronic attack technology, such as high-powered, agile beam-jamming techniques and solid-state electronics to deny, degrade, and disrupt enemy threats while protecting U.S. and coalition forces. Raytheon's NGJ will provide airborne electronic attack and jamming capabilities, and will include cyber-attack capabilities using the aircraft's active electronically scanned array radar to insert tailored data streams into enemy radar and communications systems.

Raytheon will use its gallium nitride (GaN)-based AESA technologies and an open-systems architecture for the NGJ design. Raytheon will do the work in El Segundo, Calif.; Forrest, Miss.; Dallas.; McKinney, Texas.; Torrance, Calif.; Fort Wayne, Ind.; Marion, Va.; San Diego; Andover, Mass.; and Tucson, Ariz., and should be finished by December 2020.

FOR MORE INFORMATION contact **Raytheon** at *www.raytheon.com*.

Headwall introduces multispectral sensor fusion for UAS

Headwall Photonics in Fitchburg, Mass., is introducing the HyperCore embedded computing unit for unmanned aircraft systems (UAS) applications that require multispectral sensor fusion. Using Hyperspec III spectral imaging software, HyperCore serves as the central connection point for remote-sensing instruments such as multiple hyperspectral sensors, LiDAR, thermal cameras, RGB instruments, and GPS/IMU units. Small size and weight combine with data processing and high-capacity storage in a processing platform for fusing hyperspectral sensing data with many other sensor payloads on the aircraft. For harsh airborne environments, HyperCore stores 500 gigabytes of incoming airborne data and features two Gigabit Ethernet connections.

General Dynamics acquires Bluefin Robotics

Executives are boosting General Dynamics' expertise in unmanned underwater vehicle (UUV) technologies with the acquisition of Bluefin Robotics in Quincy, Mass. Bluefin Robotics will become part of the Maritime and Strategic Systems business line of General Dynamics Mission Systems in Fairfax, Va. The companies have been collaborating on the Knifefish mine-hunting UUV for the U.S. Navy.

Army eyes hand-launched squad drone the weight of a baseball

BY **John Keller**

Army researchers are surveying industry for the ability to design and manufacture small drones to provide squad members with fast, short-range battlefield surveillance.

ABERDEEN PROVING GROUND, Md. — U.S. Army researchers are asking for industry's help in designing an unmanned aerial drone about the weight of a baseball to enable forward-deployed infantry to conduct 15-minute reconnaissance missions.

Officials of the Army Contracting Command at Aberdeen Proving Ground, Md., issued a request for information (W91CRBRequestforInformation) for the Soldier Borne Sensors (SBS) program to develop a personal battlefield surveillance drone for Army infantry. The entire system —consisting of control console, display, and unmanned aircraft — will weigh about 3 pounds; the actual aircraft will weigh about 5.29 ounces. The standalone system will have all hardware, software, radio equipment, batteries, and a tactical carrying pouch and is to be flown by one operator; display incoming video and telemetry data in near real time during the day, at night, and in light precipitation.

The system will be able to return to a predetermined location if it loses its radio link; have a display that is readable during the day and at night; accept standard battery charging; have an unmanned aircraft able to fly in manual mode and by waypoint navigation; and have an operating radius of 500 meters for 15 minutes.

The system's display must have sufficient resolution for a trained operator to detect a man-sized target with a 90-percent probability. The unmanned aerial vehicle (UAV) must be able to be launched and recovered by hand while the operator is lying down under cover. The operator must be able to set up the system and launch the UAV within 60 seconds, and the UAV must be able to fly reliably in 10-knot winds with gusts to 15 knots.

The Army Contracting Command is issuing its request for information on behalf the Army's Product Manager Soldier Maneuver Sensors (PM SMS) within the Army's Program Executive Office (PEO) Soldier.

Companies interested should e-mail two-page information papers and initial questions to the Army's Sarah Coleman at sarah.w.coleman.civ@mail.mil. For questions or concerns, contact the Army's Leo Sydlink by e-mail at Leo.J.sydlik.civ@mail.mil, or by phone at 410-278-2414.

MORE INFORMATION IS online at *https://www.fbo.gov/notices/f958d13185cc0d905a33e4922ebc173f.*

Air Force orders LAIRCM laser-based missile-defense systems

Missile-defense experts at Northrop Grumman will install Large Aircraft Infrared Counter Measures (LAIRCM) laser-based missile-defense systems for large military aircraft under terms of an $87.2 million contract modification. The Air Force Life Cycle Management Center at Wright-Patterson Air Force Base, Ohio, is asking Northrop Grumman Mission Systems in Rolling Meadows, Ill., to provide the electro-optical LAIRCM for a variety of U.S. military aircraft. LAIRCM automatically detects a missile launch, determines if it is a threat, and activates a high-intensity, laser-based countermeasure system to track and defeat the missile, Northrop Grumman officials say. The system is for Air Force C-5, C-17, C-37, and C-40 cargo and utility jets; Air Force C-130H and MC-130W four-engine utility turboprop aircraft; CV-22 tiltrotor aircraft; KC-46 aerial refueling jet; as well as the U.S. Navy P-3 maritime patrol jet. LAIRCM also can fit on some large military helicopters. LAIRCM focuses high-intensity laser energy at the infrared seeker head of incoming missiles to blind the missile and force it off its target. The system is designed to protect large aircraft from shoulder-fired, vehicle-launched, and other infrared-guided missiles when the planes are operating close to the ground, such as on takeoff and landing and during low-level operations and aerial refueling. ←

Electro-optical sensor designers shrinking infrared pixel size to enhance resolution

BY **John Keller**

BALTIMORE — Cooled and uncooled infrared sensor image resolution is improving, as electro-optical pixel size is shrinking from 17 microns to 12 microns, say experts at SOFRADIR in Palaiseau, France. Smaller pixel size not only means better infrared image resolution, but also longer range and potentially smaller size and weight because of reduced need for sensor cooling, says Philippe Bensussan, the SOFRADIR chairman and CEO.

Infrared sensors are important imaging sources on platforms ranging from orbiting satellites to soldier rifle sights, and everything in-between. They play key roles in applications like military night vision, structure fire detection, missile guidance, and enhanced vision systems.

Infrared sensors in the most demanding applications typically use cooling. Long-wave infrared relies on detecting the differences between temperatures of objects in its field of view. Cooling heightens that ability, but also increases system size, weight, power consumption, and cost.

Enhanced resolution could enable designers to build smaller infrared sensors for use in rifle sights, handheld sensors, body-worn detectors, and a wider variety of unmanned vehicles. Smaller pixel size offers the potential to use several sensors in a system, which can enable new capabilities like wide-field-of-view surveillance that stitches together imagery from multiple sensors.

Night vision and other infrared imagery is improving in resolution as sensor designers shrink the size of infrared image pixels.

Enhanced resolution also has the potential to reduce system power consumption, which has a direct influence on battery-powered systems. Less power means fewer batteries, which is good news for any infantry warfighter who has to go on patrol with a heavy load.

Think again about cooling. Enhanced sensor resolution also could reduce or eliminate the need for sensor cooling, which can reduce system complexity, size, weight, and cost, as well as enhance reliability.

As for the transition from 17-micron to 12-micron pixels in infrared sensors, SOFRADIR's Bensussan says his company is in the research-and-development stage now, with prototype systems in test and demonstration. The company will take this technology to market sometime next year, he says. ←

FOR MORE INFORMATION visit **SOFRADIR** online at *www.sofradir.com*.

PRODUCT applications

ENERGY STORAGE

Saft to provide energy storage and power electronics support for Navy electromagnetic railgun

U.S. Navy researchers needed energy storage technologies to help develop a long-range shipboard weapon that fires projectiles using electrical power instead of chemical propellants. They found their solution at battery designer Saft America Inc. in Cockeysville, Md.

Officials of the Naval Surface Warfare Center (NSWC) in Dahlgren, Va., have announced plans to award a sole-source contract to Saft to help Navy researchers develop non-propagating energy storage modules for the future electromagnetic railgun. The Navy's electromagnetic railgun project seeks to use magnetic fields created by high electrical currents to accelerate a sliding metal conductor between two rails to launch projectiles at 4,500 miles per hour — or nearly six times the speed of sound. Such a shipboard weapon would use kinetic energy, rather than explosives, to destroy or disable targets at sea, such as surface warships, fast attack boats, helicopters, and fixed-wing aircraft.

The Navy's future electromagnetic railgun will use electricity generated by its host ship and stored over several seconds in a pulsed power system. The weapon sends an electric pulse to the railgun to create an electromagnetic force accelerating a projectile that looks like a gigantic blunt-end open wrench to speeds as fast as Mach 6. The wrench-like projectile moves so quickly that it trails a plume of fire from its kinetic energy.

The weapon would eliminate the hazards of high explosives in the ship and unexploded ordnance on the battlefield, Navy officials say. NSWC-Dahlgren performs research in complex naval warfare systems, such as the electromagnetic railgun and the shipboard Laser Weapon System (LaWS).

The Navy's near-term goal is a 20- to 32-megajoule weapon that shoots a distance of 50 to 100 nautical miles. Navy officials want a rate of fire for the electromagnetic railgun of at least 10 rounds per minute. The pulsed power system will provide the electrical power necessary for this rate of fire.

FOR MORE INFORMATION visit **Saft America** online at *www.saftbatteries.com.*

ANTENNAS

Harris to provide SATCOM aboard Navy surface warships

Officials of the Space and Naval Warfare Systems Command (SPAWAR) in San Diego, are asking Harris Corp. in Melbourne, Fla., to provide Commercial Broadband Satellite Program (CBSP) Force Level Variant (FLV) SATCOM equipment to the U.S. Navy under a $10.3 million contract.

The order includes two CBSP FLV dynamic shipboard systems, three CBSP FLV dual-antenna and dual-channel systems, and one CBSP FLV dynamic shipboard system with radar cross section reduction for aircraft carriers, amphibious assault ships, and other large-deck Navy surface ships. The CBSP FLV provides the Navy with terminal-to-shore, space, and terrestrial connectivity to increase data throughput, improve reliability, and provide redundancy. The Harris equipment involves 8.9-foot terminals with C- and Ku-band capabilities. The equipment's relatively high bandwidth capacity enables Navy communications experts to provide high-speed Internet access for as many as 5,000 military personnel onboard each surface warship.

On this contract modification, Harris Corp. will do the work in Melbourne, Fla., and should be finished by January 2017.

FOR MORE INFORMATION visit **Harris Corp.** online at *www.harris.com.*

ADVERTISERS INDEX

Military & Aerospace Electronics

GROUP PUBLISHER Alan Bergstein
603 891-9447 / alanb@pennwell.com

EDITOR-IN-CHIEF John Keller
603 891-9117 / jkeller@pennwell.com

EXECUTIVE EDITOR Courtney E. Howard
509 413-1522 / courtney@pennwell.com

CONTRIBUTING EDITOR
WESTERN BUREAU J. R. Wilson
702 434-3903 / jrwilson@pennwell.com

EDITORIAL ART DIRECTOR Cindy Chamberlin

PRODUCTION MANAGER Sheila Ward

SENIOR ILLUSTRATOR Chris Hipp

AUDIENCE DEVELOPMENT MANAGER Debbie Bouley
603 891-9372 / debbieb@pennwell.com

AD SERVICES MANAGER Glenda Van Duyne
918 831-9473 / glendav@pennwell.com

MARKETING MANAGER Gillian Hinkle
603 891-9126/ gillianh@pennwell.com

PennWell®
www.pennwell.com

Editorial offices
PennWell Corporation,
Military & Aerospace Electronics
61 Spit Brook Road, Suite 401, Nashua, NH 03060
603 891-0123 • FAX 603 891-0514 • www.milaero.com

Sales offices

EASTERN US & EASTERN CANADA & UK
Bob Collopy, Sales Manager
603 891-9398 / Cell 603 233-7698
FAX 603 686-7580 / bobc@pennwell.com

WESTERN CANADA & WEST OF MISSISSIPPI
Jay Mendelson, Sales Manager
4957 Chiles Drive, San Jose, CA 95136
408 221-2828 / jaym@pennwell.com

REPRINTS Jessica Stremmel
717 505-9701 x2205 / Jessica.stremmel@theygsgroup.com

DIRECTOR LIST RENTAL Kelli Berry
918 831-9782 / kellib@pennwell.com

For assistance with marketing strategy or ad creation, please contact PennWell Marketing Solutions
Paul Andrews, Vice President
240 595-2352 / pandrews@pennwell.com

Corporate Officers
CHAIRMAN Robert F. Biolchini
VICE CHAIRMAN Frank T. Lauinger
PRESIDENT AND CHIEF EXECUTIVE OFFICER Mark C. Wilmoth
EXECUTIVE VICE PRESIDENT, CORPORATE DEVELOPMENT AND STRATEGY Jayne A. Gilsinger
SENIOR VICE PRESIDENT, FINANCE AND CHIEF FINANCIAL OFFICER Brian Conway

Technology Group
SENIOR VICE PRESIDENT/PUBLISHING DIRECTOR Christine Shaw

SUBSCRIPTION INQUIRIES
Phone: 847 763-9541 • Fax: 847 763-9607
E-mail: mae@halldata.com
Web: www.mae-subscribe.com

BPA WORLDWIDE
AMERICAN BUSINESS MEDIA
The Association of Business Media Companies

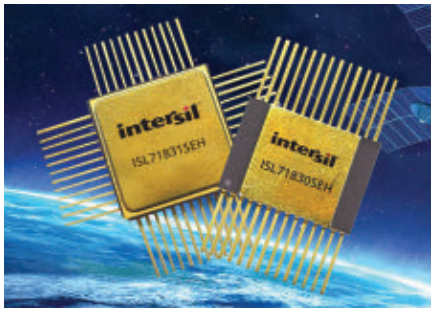
new PRODUCTS

To submit new products for consideration, contact John Keller at jkeller@pennwell.com.

SPACE ELECTRONICS

5-volt radiation-tolerant multiplexers introduced by Intersil

Intersil in Milpitas, Calif., is introducing two single-supply, 5-volt radiation-tolerant multiplexers for satellite and space exploration applications. The 16-channel ISL71830SEH and 32-channel ISL71831SEH multiplexers join Intersil's 30-volt multiplexers, which have been onboard several satellite and space exploration missions, including NASA's Orion spacecraft flight test. The 5-volt multiplexers address the growing trend toward reduced system voltage rail. They provide data acquisition systems with electrostatic discharge (ESD) protection, and deliver lower RON and input leakage for reduced power consumption and higher signal integrity. The 5-volt multiplexers also offer fast propagation delays, which significantly improve signal processing response time.



FOR MORE INFORMATION visit **Intersil** online at *www.intersil.com*.

SINGLE-BOARD COMPUTERS

6U VME single-board computer introduced by Curtiss-Wright

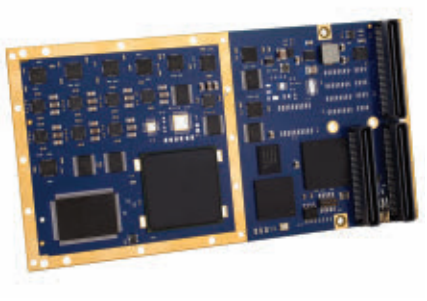
Curtiss-Wright Defense Solutions in Ashburn, Va., is debuting the SVME/DMV-196 Power Architecture-based 6U VME single-board computer for rugged defense and aerospace embedded computing applications. The rugged computer board offers FPGA-based Helix PCI Express to VME64x Interface, and has on-card integrated MIL-STD-1553B interfaces. It will also be available with the interfaces removed, for applications that do not require the MIL-STD-1553B option. Each of the T2080 processor cores has an AltiVec engine that runs at the core frequency. For upgrading applications based on AltiVec algorithms, it enables customers to use their proven existing algorithms while providing an increase in performance and a reduction in power. The SVME/DMV-196's T2080 processor has as much as 16 gigabytes of DDR3 memory.

FOR MORE INFORMATION visit **Curtiss-Wright Defense Solutions** online at *www.curtisswrightds.com*.

AVIONICS

32-channel rugged ARINC PMC and XMC boards introduced by DDC

Data Device Corp. (DDC) in Bohemia, N.Y., is introducing the DD-40002X high-density, 32-channel ARINC PMC and XMC boards for avionics applications in rugged environments. The boards offer advanced functionality, with programmable and fixed I/O configurations. The DD-40002X boards support maximum data throughput on all channels, while providing DMA for low CPU utilization, error detection, and label filtering per channel. These PMC/XMC boards can be used in conduction- or air-cooled applications, to serve both commercial and military aerospace requirements. Offering high mean-time-between-failures, the board operates in temperatures from -40 to 85 degrees Celsius at the thermal rail, without any limitations on ARINC 429 transmitter duty cycles.



FOR MORE INFORMATION visit **DDC** online at *www.ddc-web.com*.

RUGGED COMPUTERS

Rugged zero client for warfighters introduced by Chassis Plans

Chassis Plans in San Diego is presenting the CPZ-156T Zero Client packaged in a rugged enclosure to support warfighters in the harshest conditions. The rugged device incorporates a Dell PCoIP ASIC controller and a 15.6-inch liquid crystal display with 10-point multi-touch screen. The unit conforms to PCoIP using the Teradici TERA2321 controller. Power over Ethernet (PoE) provides power for the system in single-cable operation. The CPZ-156T also is impervious to malware, virus, and other cyber-attack vectors and offers the highest levels of security, company officials say.

FOR MORE INFORMATION visit **Chassis Plans** online at *www.chassis-plans.com*.

Military & Aerospace Electronics 2016 Innovators Awards

CALL for ENTRIES

Innovation Wanted!

This November, Military & Aerospace Electronics will celebrate the most-innovative applications of aerospace and defense electronics technology products and systems.

Inspire others through technology innovations within the military and aerospace market.

- Outstanding publicity for your company
- Great attention for your project
- Limelight for your customers
- Exposure for your career

Enter new products or new applications for existing products

Awards will be presented to organizations that **demonstrate excellence** in the use of a product or system. Designers, integrators, and users of military and aerospace electronics systems may **nominate their own projects** or applications, or integrators or distributors that supplied products or systems can **nominate exceptional projects** for consideration.

If you know of an application worthy of consideration, but the user organization requires anonymity or non-disclosure, your entry can refer to the user organization in general rather than specific terms.

For more details visit: militaryaerospace.com/innovators-awards

ENTER BY: June 17, 2016 to SAVE $100

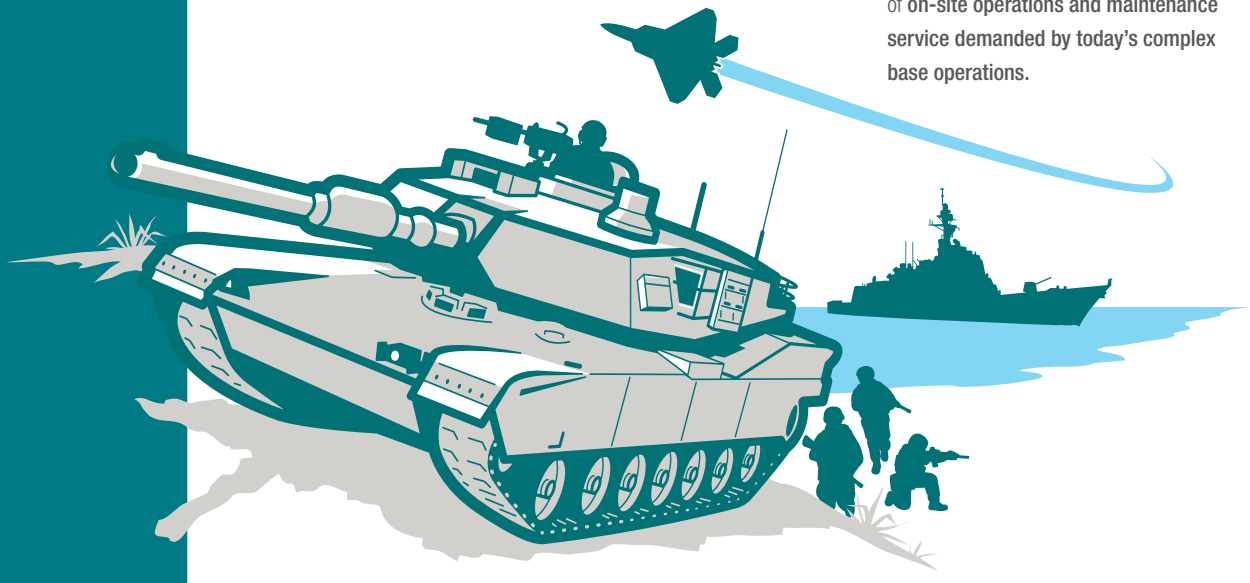
FINAL DEADLINE: July 1, 2016

PennWell®

What *don't* we do for the US Military?

While we don't drive the armored vehicles or pilot the jet fighters, EMCOR has plenty of boots on the ground to help keep our troops and their facilities more efficient and ever ready. Below is just a sample of how we help the military accomplish its missions...

It's all about support—24/7/365 our people are on call for virtually every type of **on-site operations and maintenance service demanded by today's complex base operations.**



EMCOR Government Services takes many forms—our people support key facilities for the **Army, Navy, Air Force, Marines, U.S. Coast Guard and more.**

High-tech, high-performance facilities require a higher caliber of preventive maintenance and repair—**we are proud to provide vital services and Base Operations Support nationally.**

MISSIONS ACCOMPLISHED

FEDERAL AGENCIES | U.S. MILITARY | NATIONAL SECURITY | SPACE | WASHINGTON D.C. | HEALTHCARE SUPPORT

EMCOR Government Services

WHAT CAN WE ACCOMPLISH FOR YOU?

emcor_info@emcor.net 866.890.7794 emcorgovservices.com